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ELECTRIC MOTORS FOR USSR CENTRIFUGAL OIL PUMPS

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Of late, our oil-refining industry has been equipped with more and more new types of centrifugal pumps made by the machine-building plants of the Ministry of Petroleum Industry and the Ministry of Machine and Instrument Building.

In the great majority of premises where H521-48 pumps are installed for pumping various cold and hot petroleum products, as well as compressed petroleum gases, steam and the gas of hydrocarbons (from methane to pentane, inclusive) may be present and form explosive mixtures with air. Pentane forms the most dangerous mixture with air.

These facts must be considered in selecting electric motors for centrifugal oil pumps.

According to the pump characteristics, the motor power should be from 5 to 700 kw at a synchronous speed of 3,000 rpm and from 5 to 150 kw at a synchronous speed of 1,500 rpm.

Power and Type of Electric Motors

If the electric motor is to operate in the same room as the centrifugal oil pumps, it must be constructed to satisfy the requirements for explosion-proof motors in the presence of an explosive pentane and air mixture.

Use, for the above purposes, of motors of the MA-140 series intended to operate only in an atmosphere containing minedamp (methane) is a violation of the regulations in force for installing electrotechnical apparatus in premises liable to explosion.

The maximum power of an electric motor for such explosion-proof performance must not exceed 150 kw since further increase in the power would complicate the construction of the motor and might make its manufacture and operation economically unprofitable.

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Special motors with a power of more than 150 kw and 3,000 rpm, with provision for cooling them with clean outside air, have not been produced by domestic industry. Manufacturing and putting them in operation would take a long time.

Besides, separately ventilated motors require an interlocking system which will guarantee that (1) the motors are automatically switched off when the pressure of clean air on the jacket falls lower than the pressure of the surrounding atmosphere or is equal to it, and (2) the voltage will not be applied to the motor until it is initially ventilated with clean air.

In accordance with the above statements, in cases where electric motors with a power of over 150 kw and 3,000 rpm are needed for driving centrifugal oil pumps, it is possible to use the standard motors mass-produced by plants of the Ministry of Electrical Industry. The method of connecting them with the pumps, which involves the use of an intermediate shaft passing through the main wall dividing the pump room from the motor room, is commonly employed in oil refineries and oil-drilling enterprises.

Rotor Type

Whether the centrifugal pumps start when the pressure valve is open or shut, the starting moment for the motors of these pumps does not exceed the normal moment of the motor. Hence, all electric motors for these pumps can have squirrel-cage rotors.

Insulation of Windings and Protective Grounding

In the southern regions of our country the temperature of the air in hot oil pump rooms often reaches 50° C.

The excess of the temperature in the windings over that of the air reaches 60° C. Therefore, the insulation for the windings of explosion-proof motors operating in the same room as the pumps should not be lower than Class B.

It should be noted that most types of the MA-140 series explosion-proof electric motors have Class A insulation. Hence, their use in the neighborhood of hot pumps is inadmissible. Another serious fault in the MA-140 series is the presence of an external bolt for grounding the frame. This is contrary to the regulations for manufacturing explosion-proof motors. Explosion-proof motors must have a special clamp for the protective ground connection in the motor's terminal box into which a four-strand cable is led.

Voltage for Electric Motors

In selecting a voltage for an explosion-proof motor, special attention should be given to the prevailing standard voltages of 380 and 6,000 volts.

It is recommended that all explosion-proof motors be made to operate on 380 volts. Electric motors up to 100 kw in size must have six outlet terminals for switching over to the 220-volt networks which are in use in the older oil-well regions.

New Enclosed Electric Motors of the Explosion-Proof Type

In 1949 the Khar'kov Electromechanical Plant, in accordance with instructions from the Ministry of Petroleum Industry, built and put into operation four types of three-phase electric motors (MA-35) with squirrel-cage rotors and rated at 3,000 rpm, for explosion-proof duty in driving centrifugal oil pumps.

The MA-35 series is a modification of the MA-140 series embodying changes in the frame and in the stator winding. Models of these motors were tested by the Makeyevka Scientific Research Institute. MA-35 series motors have Class B winding insulation, are designed for continuous operation with an ambient temperature of 55° C, and, in addition, have a terminal box intended for use with a four-strand cable whose fourth lead is for the protective grounding. The characteristics of the MA-35 series motors are given in the table below.

Type	Power (kw)	Stator Current (amp)	Efficiency (%)	Power Factor	I_{start}/I_{nom}	M_{start}/M_{nom}	M_{max}/M_{nom}
MA-35-42/2	25	80.7/46.6	89.0	0.9	10.0	2.0	3.0
MA-35-52/2	50	163/94.1	90.0	0.9	7.5	1.5	3.0
MA-35-62/2	90	282/163	91.0	0.905	7.5	1.5	3.0
MA-35-71/2 (for only one voltage 220 or 380 v)	125	396/228	91.5	0.91	6.5	1.4	2.7

Technical data on these motors proves their acceptability. It would, however, be desirable to decrease the somewhat high starting current.

Usefulness of the New Series of Explosion-Proof Electric Motors

The work accomplished by the Khar'kov Electromechanical Plant in building the first group of the four types of MA-35 motors demonstrates the possibility of modifying the MA-140 series for obtaining electric motors of the MA-35 series rated at 5.5-85 kw, 1,500 rpm, and 7.5-125 kw, 3,000 rpm. These modifications would make it necessary to design only three types of MA-35 series motors, namely, 150 kw, 3,000 rpm, and 125 and 150 kw, 1,500 rpm. Until they are in use, the last two types can be replaced by the present enclosed motors of the AM6 series, separately ventilated through pipes.

The explosion-proof MA-35 series can also be used widely in other branches of industry in premises where there is danger of explosion.

The only equipment needed for starting and measuring purposes in the room housing the centrifugal pumps consists of a control button and an ammeter. The remaining apparatus can function normally in other premises where there is no danger of explosion.

The KUV control button is not suitable for the petroleum industry, but could be modified. Explosion-proof ammeters are made of the glass used in explosion-proof light fixtures.

Conclusions

1. To drive centrifugal oil pumps, electric motors with a power of 5-150 kw must have explosion-proof V2B performance (i.e., against pentane, etc.) and be installed on a common base with the pumps. But electric motors with a power exceeding 150 kw must be of normal type installed in adjacent premises.

2. All but three types of the V2B explosion-proof series can be produced by altering the MA-140 series motors.

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3. All electric motors for centrifugal oil pumps should have standard voltages of 380 and 6,000 volts. Explosion-proof motors should be made for 380 volts, while motors of up to 100 kw should have six outlet terminals for use with 220-volt networks.

4. Explosion-proof electric motors can be used in other branches of industry. This will curtail production of motors of the MA-140 series.

5. The minimum essential starting and measuring apparatus consists of a control button and an ammeter of a type corresponding to the physical properties of the working area. Clamps for the grounding conductors should be inside the equipment.

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